19. Obtain expression for probability density and probability and probability current density in the Dirac formalism.

20. State the classical field equation and explain the quantities involved therein.



**NOVEMBER/DECEMBER 2024**

**23PPH31 — QUANTUM MECHANICS – II**

Shanmuga Industries Arts & Science College T.V.Malai

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. What is scattering amplitude?
2. Define partial waves.
3. List the differences between harmonic and constant perturbation.
4. What is electric dipole transition moment?
5. Mention the properties satisfied by Dirac's matrices.
6. What do you mean by negative energy states of electron?
7. Write the properties of gamma matrices.
8. Define Bilinear covariant.
9. Give the properties of creation and annihilation.
10. Define number operator and write its equation of motion.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Define differential scattering cross section and total cross-section. What is the unit in which they are measured?

Or

(b) Obtain an expression for the phase shift $\delta_0$ for $s$-wave scattering by the potential $V = \begin{cases} \infty & \text{for } 0 \le r \le a \\ 0 & \text{for } r > a \end{cases}$.

12. (a) Explain Fermi's golden rule.

Or

(b) Give an brief account on semi classical theory of radiation.

13. (a) If $\vec{\alpha}$ represent three Dirac matrices $\alpha_x, \alpha_y, \alpha_z$ and $B$ and $C$ are usual three-dimensional vectors, then show that $(\vec{\alpha}.B)(\vec{\alpha}.C) = B.C + i\vec{\sigma}'.B \times C$.

Or

(b) Using Dirac's relativistic theory obtain the expression for the magnetic moment of electron.



14. (a) Express Dirac's equation in the covariant form.

Or

(b) Show how Dirac's relativistic wave equation for an electron leads to the theory of positrons.

Shanmuga Industries Arts & Science College T.V.Malai

15. (a) State and explain the classical field equation in Hamiltonian form.

Or

(b) What are creation, annihilation and number operator? Why are they called so?

SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. Estimate the cross section for $S$ wave scattering by square well potential.

17. Discuss the Einstein's coefficients of spontaneous and induced emission of radiation. Derive the relation between the A and B coefficients.

18. Derive the Klein-Gordan equation of a free particle. Hence define the current densities and mention its shortcomings.